CLAIMS

1. A process for preparing a broad molecular weight polyethylene by polymerizing ethylene in the presence of a polymerization catalyst, the process comprising the following steps, in any mutual order:

   a) polymerizing ethylene, optionally together with one or more α-olefinic comonomers having from 3 to 12 carbon atoms, in a gas-phase reactor in the presence of hydrogen,

   b) copolymerizing ethylene with one or more α-olefinic comonomers having from 3 to 12 carbon atoms in another gas-phase reactor in the presence of an amount of hydrogen less than step a),

   where in at least one of said gas-phase reactors the growing polymer particles flow upward through a first polymerization zone (riser) under fast fluidization or transport conditions, leave said riser and enter a second polymerization zone (downcomer) through which they flow downward under the action of gravity, leave said downcomer and are reintroduced into the riser, thus establishing a circulation of polymer between said two polymerization zones.

2. The process according to claim 1, wherein step a) is performed upstream step b).

3. The process according to anyone of claims 1-2, wherein the ethylene polymer obtained from step a) has a density higher than 0.955 kg/dm^3.

4. The process according to any of claims 1-3, wherein the ethylene polymer obtained from step a) has a melt flow rate MIE in the range of 10 to 400 g/10 min.

5. The process according to claim 4, wherein the MIE is from 100 to 200 g/10 min.

6. The process according to anyone of claims 1-5, wherein in step a) the hydrogen/ethylene molar ratio is comprised between 0.5 and 5.0, the ethylene monomer being comprised between 5 and 50 % by volume.

7. The process according to anyone of claims 1-6, wherein the operating temperature in step a) is selected between 50 and 120°C.

8. The process according to anyone of claims 1-7, wherein the operating pressure in step a) is between 0.5 and 10 MPa.

9. The process according to claim 1, wherein step a) is performed in a fluidized bed reactor.

10. The process according to claim 1, where step a) and b) are carried out in a sequence of two gas-phase reactors in which the growing polymer particles flow upward through a riser under fast fluidization conditions, leave said riser and enter a downcomer through which they flow downward under the action of gravity, leave said downcomer and are reintroduced into the riser.

11. The process according to anyone of claims 1-10, wherein the ethylene polymer obtained from step a) represents from 40 to 65% by weight of the total ethylene polymer produced in the overall process.

12. The process according to any of claims 1-11, wherein the ethylene polymer and the entrained gas coming from step a) are passed through a solid/gas separator and the separated polymer is fed to the reactor of step b).

13. The process according to anyone of claims 1-12, wherein the operating temperature in step b) is in the range from 65 to 95°C.

14. The process according to anyone of claims 1-13, wherein the operating pressure in step b) is in the range from 1.5 to 4.0 MPa.

15. The process according to anyone of claims 1-14, wherein the α-olefin comonomer of step b) is selected from 1-butene, 1-pentene, 1-hexene, 4-methyl-1-pentene, 1-heptene and 1-octene.

16. The process according to any of claims 1-15, wherein the reactor of step b) is operated by establishing different conditions of monomers and H_2 concentration within said riser and said downcomer.

17. The process according to claim 16, wherein said different conditions are achieved by feeding a gas and/or a liquid mixture into said downcomer, said gas and/or liquid mixture having a composition different from that of the gas mixture present in said riser.

18. The process according to anyone of claims 16-17, wherein the hydrogen/ethylene molar ratio in said downcomer of step b) is comprised between 0.005 and 0.2, the ethylene concentration being comprised from 1 to 20 % by volume.

19. The process according to anyone of claims 16-18, wherein the comonomer concentration in said downcomer of step b) is from 0.3 to 5 % by volume based on the total volume of gas present in said downcomer.

20. The process according to anyone of claims 16-19, wherein the hydrogen/ethylene molar ratio in said riser of step b) is comprised between 0.05 and 0.3, the ethylene concentration being comprised from 5 to 15 % by volume

21. The process according to anyone of claims 16-20, wherein the comonomer concentration in said riser of step b) is from 0.1 to 3.0% by volume based on the total volume of gas present in said riser.

22. The process according to claims 1-21, wherein an ethylene polymer endowed with at least a tri-modal molecular weight distribution is obtained.

23. The process according to claim 22, wherein said ethylene polymer has a melt index MIF in the range of 5 to 40 g/10 min and a melt index MIP in the range of 0.1 to 1 g/10 min.

24. The process according to claims 22-24, wherein the MIF/MIP ratio is in the range of 20 to 50.

25. The process according to anyone of claims 22-25, wherein said ethylene polymer has a density comprised between 0.935 and 0.955 kg/dm^3.